

## GENETICAL AND ENVIRONMENTAL FACTORS AFFECTING SLAUGHTER TRAITS IN BEEF PRODUCTION EXPERIMENTS IN FIELD

HILKKA KENTTÄMIES

*University of Helsinki, Department of Animal breeding, 00710 Helsinki*

**Abstract.** During the years 1971-77 the carcass weight of fattening calves delivered from dairy herds increased by 40 kg. During the same period the differences between areas grew smaller. The growth rate and carcass traits were affected by feed type of the farm, rearing time, sex of the calf and breed of sire. In comparison with the Ayrshire bulls, the carcass weight of contemporary Charolais bulls was 16 and of Friesian 12 %-units higher, but of Finncattle bulls 7%-units lower. Differences between heifers were still larger. The growth rate of Ch and Fr remained on a high level longer than that of Ay and Fc. The heritability estimates of Ay and (Fr) were .23 (.61) for carcass weight, .39 (.77) for net growth, .14 (.15) for carcass score and .06 (.26) for fatness score. Differences between farms within feed type consisted of about 50 % of the variation in growth rate and carcass weight, and about 25 % in carcass scores. Feeding was more consistent on farms with mere indoor feeding than on farms where the animals were also kept on pasture.

### Introduction

Beef production in Finland is mainly based on calves from dairy herds. In 1982 there were about 680 000 dairy cows and 8000 beef cows in the country. At the same time about 160 000 calves were delivered from dairy to other herds for fattening for beef. Half of the beef from young cattle slaughtered at slaughterhouses was obtained from farms rearing delivered calves.

The growth potential and carcass characteristics of young cattle and factors affecting them have been studied at the Experimental Stations since 1960, at the Performance Testing Stations since 1966, and on data collected from practice (e.g. VARO 1969, LINDSTRÖM & MAIJALA 1970, MAIJALA 1972, KOSSILA & LAMPILA 1974, RUOHOMÄKI 1981, OJALA 1982). In practice the data were collected from milk recording farms and farms specializing in fattening calves.

Experiments on the beef producing farms were started in 1969 by the Institute of Animal Breeding, Agricultural Research Centre, in cooperation with the organizations of the field and some private farms. The trials, carried out in relatively large units, were expected to give more reliable data for e.g.

comparing genetically different groups than material collected from dairy herds, where beef production is often occasional and the number of fattened animals is small.

The purpose of the present study was to investigate in practical circumstances the differences and variation in growth rate and carcass quality in different breed groups under varying conditions, the genetical and environmental factors affecting growth rate and carcass quality of beef animals, and to get practical experience for developing beef recording systems.

## Material and methods

The material consisted of beef production data of 4209 animals on 179 farms in different parts of the country. The data were collected in 1971–76 from field experiments carried out by the Institute of Animal Breeding, Agricultural Research Centre, in cooperation with the slaughterhouse and extension organizations as well as the A. I. societies, and in 1974–77 from beef records kept by the Finnish Animal Breeding Association.

By composition the material corresponded with the average commercial calf material: by sex 90 % were bulls and 10 % heifers; by breed of sire 70 % were Ayrshire (Ay), 20 % Friesian (Fr), 5 % Finncattle (Fc), 4 % Charolais (Ch), and less than 1 % Hereford (Hf) and Aberdeen Angus (Ab). The samples were divided according to the breed division in the A. I. statistics (ANON. 1970 and 1976).

Most farms acquired the calves at the age of 2 weeks through slaughterhouses, while some obtained them directly from neighbours or from their own herd. The calves were marked with a numbered plastic ear mark and data from birth till slaughterhouse were collected on a beef recording card. The data were computed at the Institute of Animal Breeding using programs planned for the on-farm test and library programs. The results were reported to the farms and organizations involved.

The country was divided into four areas according to the coverage of the co-operative slaughterhouses (Fig. 1). About half of the samples were from Area 2.

## Rearing

Rearing plans were recorded in outline. On most farms feeding was based on green silage fodder with some domestic concentrates. On some farms the animals were also kept on pasture. In order to eliminate the effect of feeding in the analysis of growth performance, the farms were divided into five feed types (KENTTÄMIES 1974 and 1975) by main fodder and intensity of feeding. The feed types were defined as follows:

- 1) Green line feeding (silage, pasture, some concentrates)
- 2) Scanty feeding (both roughage and concentrates less than needed)

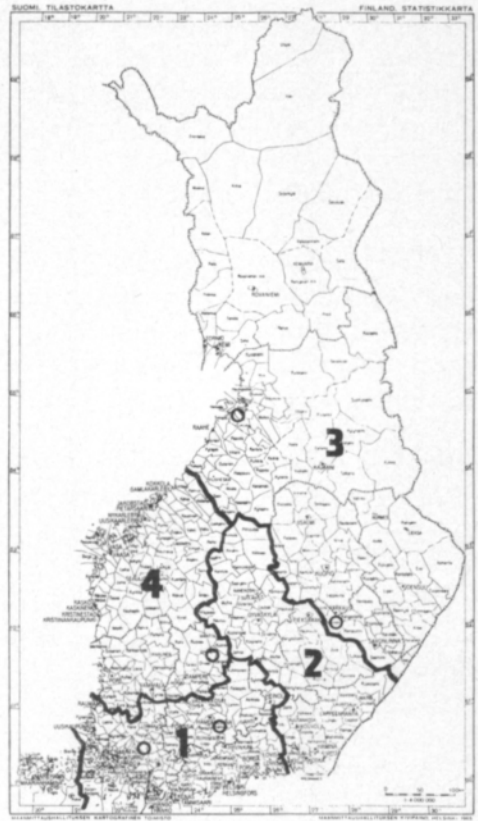


Fig. 1. Areas covered by the co-operative slaughterhouses.

- 3) Standard feeding (silage, concentrates 40–60 % of f.u.)
- 4) Intensive feeding (silage, concentrates 60–80 % of f.u.)
- 5) Hay feeding (hay, pasture, concentrates)

Feed type was recorded for  $\frac{3}{4}$  of the animals. More than half of the animals were included in the group standard feeding (type 3), one third in the roughage feed types including pasture (1 and 5), 11 % in intensive feeding (4) and 7 % in scanty feeding (2).

Rearing time varied between 219–599 days, partly because of feed type and partly because of some other farmdependent factor. The animals were divided into two age groups. There were approximately the same number of animals in each group (219–419 vs. 420–599 d). In the two age groups the animals were divided equally by breed, with the exception that there were 1.5 times more Friesians in the older than in the younger age group. In the feed type green line feeding the animals were more often included in the older than in the younger group.

- The traits to be studied were
- rearing time, d (interval between transport or the age of 14 d till slaughter)
- carcass weight, kg
- net growth, g/d (carcass weight – 0.5 × calf weight divided by rearing time)

carcass quality, scores (total, fatness)

Prior to certain analyses the carcass weights were corrected to a certain age by using individual net growth.

### Comparison of breeds

The breeds were compared by breed of sire within farms using simultaneously reared animals. Ayrshire breed was used as control on each farm. The results were calculated within year or half a year as relative estimates from the age corrected values. The relative estimates were weighted with the number of animals using the formula (e.g. MASON 1957):

$$\frac{n1 \times n2}{n1 + n2}, \text{ where } n1 = \text{number of animals to be compared}$$
$$n2 = \text{number of control animals}$$

### Estimation factors affecting the traits

In order to estimate the main factors affecting slaughter traits the material was analyzed by the least squares analysis (HARVEY 1970) using the following three models:

I  $Y_{ijklmno} = u + a_i + b_j + c_k + d_l + f_m + g_n + e_{ijklmno}$ , where

$u$  = theoretical mean when unequal subclass numbers exist

$a_i$  = feed type,  $i = 1, 2, \dots, 5$

$b_j$  = breed of sire,  $j = 1, 2, 3, 4$

$c_k$  = sex,  $k = 1, 2$

$d_l$  = area,  $l = 1, 2, 3, 4$

$f_m$  = slaughter year,  $m = 1, 2, \dots, 7$

$g_n$  = rearing time,  $n = 1, 2$  (219-419; 420-599)

$e_{ijklmno}$  = random error

The effects of farm were estimated using the following model:

II  $Y_{ijklmno} = u + a_i + t_{ij} + b_k + c_l + (bc)_{kl} + d_m + f_n + e_{ijklmno}$ , where

$t_{ij}$  = effect of farm within feed type,  $j = 1 \dots 188$

$bc$  = interaction between breed and sex

Other terms were as in Model I, except that the effect of rearing time is missing. Prior to the analyses carcass weight was corrected to the average age of the material.

The effects of sire were analyzed by breed using the following model:

III  $Y_{ijklmno} = u + a_i + s_j + c_k + d_l + f_m + g_n + e_{ijklmno}$ , where

$s_j$  = effect of sire,  $j = 1 \dots 174$  (Ay),  $1 \dots 62$  (Fr); other terms as in Model I.

The terms  $t$ ,  $vs$  and  $e$  were considered random, other terms fixed.

Before analyzing the effects of sire, the material was discarded to include min. 4 progeny/sire. Rearing time was divided into four groups (219-329, 330-419, 420-499, and 500-599 d). As the number of animals in the analyses

by breed had become smaller, some groups within terms were combined: Feed type was divided into four groups consisting of roughage feeding (types 1 and 5), scanty feeding (2), concentrate feeding (3 and 4), and feeding unknown. In the term slaughter year the first and the second class were united. In the term area there was an additional fifth class including animals of Ay breed with area unknown.

The standard error of the heritability estimate was estimated using the formula of ROBERTSON (1959):

$$\text{s.e. } h^2 = (h^2 + \frac{4}{n})\sqrt{2/N}, \text{ where}$$

N = number of sires, n = number of progeny/sire

## Results and discussion

### Means

In the study, the mean rearing time was 432 d, carcass weight 187 kg, and net growth 389 g/d (Table 1). Rearing beef animals was more efficient on specialized farms than in milk recording herds (MAIJALA 1972). The traits studied included a lot of variation: the coefficient of variation (c.v.) was 20 % for rearing time, 21 % for carcass weight, and 22 % for net growth. Similarly, in field experiments in Norway the c.v. was 18 % for age corrected carcass weight after eliminating the effects of systematic factors (GRAVIR 1977).

By feed type the c.v. was the highest for scanty and hay feeding (28–30 %) and the lowest for intensive feeding (16 %). By age group the range of variation was similar. By breed within age group the c.v. for the traits of Fc bulls slaughtered at an age under 420 d was higher than of those slaughtered at an older age. The reverse was found for the other breeds. Differences in variation of net growth and carcass weight may be a consequence of different growth curves of the breeds (Fig. 5).

Table 1. Means and standard deviations of the traits.

Trait	N	Mean	S.D.
Rearing time, d	4209	431.6	86.7
Carcass weight, kg	4209	186.9	39.2
Net growth, g/d	4209	388.6	84.5
Carcass score <sup>1)</sup>	4067	8.4	.8
Fatness score <sup>2)</sup>	3807	4.0	.4

<sup>1)</sup> Carcass score: 7 = I-, 8 = I, 9 = I+, 10 = E, 11 = E+

<sup>2)</sup> Fatness score: 3 = C, 4 = A, 5 = T

### *Factors affecting the traits*

Net growth and carcass traits were significantly affected by feed type, breed of sire, slaughter year, area, sex, and age group, except the effect of feed type on total scores and the effect of breed of sire on fatness scores (Table 2). The factors mentioned above, except breed of sire, significantly affected also rearing time (age group not included in the model).

#### Year and area

In 1971–77 the carcass weight grew by 40 kg. This was mainly due to the longer rearing time and improved efficiency of rearing. Due to the government's measures it has become more profitable to grow the animals heavier than earlier. In addition, the growth potential of calves has been improved by selection of performance tested A.I. bulls as well as by the wider use of beef bulls on dairy cows for producing calves for beef production.

The differences between areas may be caused by several feed-dependent factors. Further, the activities of the slaughterhouse and extension organizations have varied in advising beef production. During the study the differences between areas grew somewhat smaller.

#### Feed type

According to several studies an adequate supply of energy is the most important factor affecting meat yield (e.g. WITT *et al.* 1971, KOSSILA & LAMPILA 1974, POUTIAINEN & TUORI 1974, RICHARDSON 1979). In spite of a shorter rearing time the carcass weights were higher on feeding based on concentrates (types 3 and 4) than on roughage and pasture (1 and 5, Table 2). This may be caused more by the differences in intensity of feeding than in rearing time. The proportion of concentrates was higher on farms fattening animals indoors than keeping the animals also on pasture. The growth rate was increasing with the intensity of feeding also when the fattened animals were kept indoors. The animals became more fatty on scanty (2) and hay (5) feeding than on intensive (4) feeding. However, the differences between feed types in age corrected carcass weights varied a little and increased with age (Fig. 2). The results are in good agreement with results from experiments (KOSSILA & LAMPILA 1974, POUTIAINEN & TUORI 1974).

#### Breed of sire

The growth potential of large beef and dual purpose breeds has exceeded that of the smaller breeds (e.g. LINDHE 1968, LIBORIUSSEN 1978, RUOHOMÄKI 1981). Similarly, in the present study the Ch crossbreds had on average the best growth rate and carcass quality and were followed by Fr, Ay

Table 2. Effect of factors influencing the carcass traits. Least squares constants and significance of F-values.

Factors	N	Traits		Carcass scores	
		Carcass weight kg	Net growth g/d	total	fatness
$\mu$	2503	169.8	353	8.5	4.0
		Constants			
Feed type					
1	525	- 1.4	-11	-0	-0
2	122	-13.2	-26	-0	.1
3	1472	3.5	9	.0	-0
4	87	19.8	43	.1	-1
5	297	- 8.7	-15	-0	.1
F (4, 2484)		***	***	-	***
Breed of sire					
Ay	1802	- 6.5	-18	-3	.0
Fc	156	-24.4	-54	-9	-0
Fr	447	8.2	15	.2	.0
Ch	98	22.7	56	1.0	-0
F (3, 2484)		***	***	***	-
Slaughter year					
71	31	-18.2	-35	-3	-2
72	201	- 8.5	- 2	-0	.1
73	342	- 5.4	- 7	.1	.1
74	597	- 4.5	-14	.1	.1
75	559	.3	- 9	-1	.0
76	596	13.4	27	.0	-0
77	177	22.9	40	.2	-0
F (6, 2644)		***	***	***	***
Area					
1	621	4.9	17	.0	-0
2	1093	- 7.5	-15	-2	-1
3	542	7.6	5	-1	-2
4	247	- 5.0	- 8	.2	.3
F (3, 2644)		***	***	***	***
Sex of calf					
heifer	238	-21.3	-54	-2	-1
bull	2265	21.3	54	.2	.1
F (1, 2644)		***	***	***	***
Age group					
219-419	1222	-14.6	20	.1	.0
429-599	1281	14.6	-20	-1	-0
F (1, 2644)		***	***	***	**

- P > .05, \*\* P < .01, \*\*\* P < .001

and Fc (Tables 2 and 3). The order was the same in each feed type, age group and sex. The Ch crossbred bulls were 16 and Fr bulls 11 %-units heavier but Fc bulls 7 %-units lighter than the contemporary Ay bulls. The differences between heifers were still larger.

The interaction between breed of sire and feed type was significant in rearing time, net growth and carcass weight corrected for the average rearing

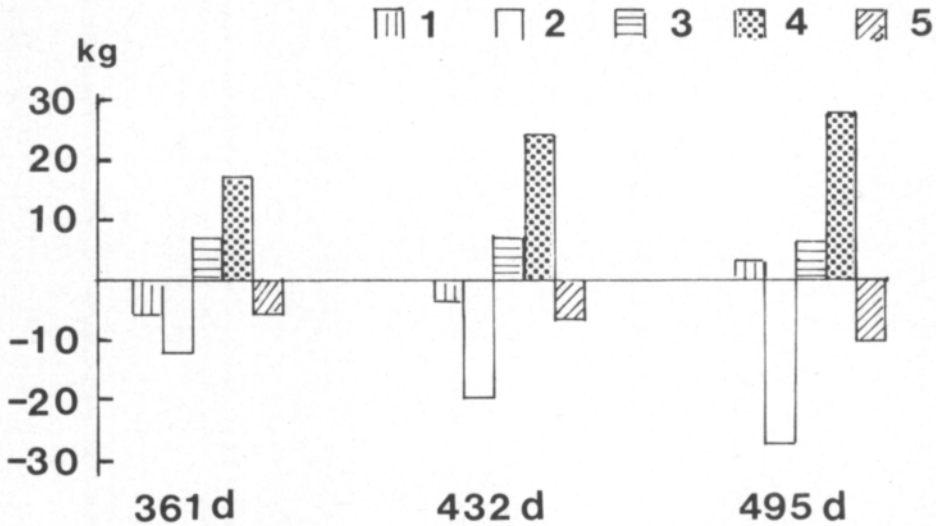


Fig. 2. Differences between feed types in carcass weight corrected for the average rearing time of the whole material and of each age group. Least squares constants. Effects of breed, sex and year have been eliminated. N = 2 662.

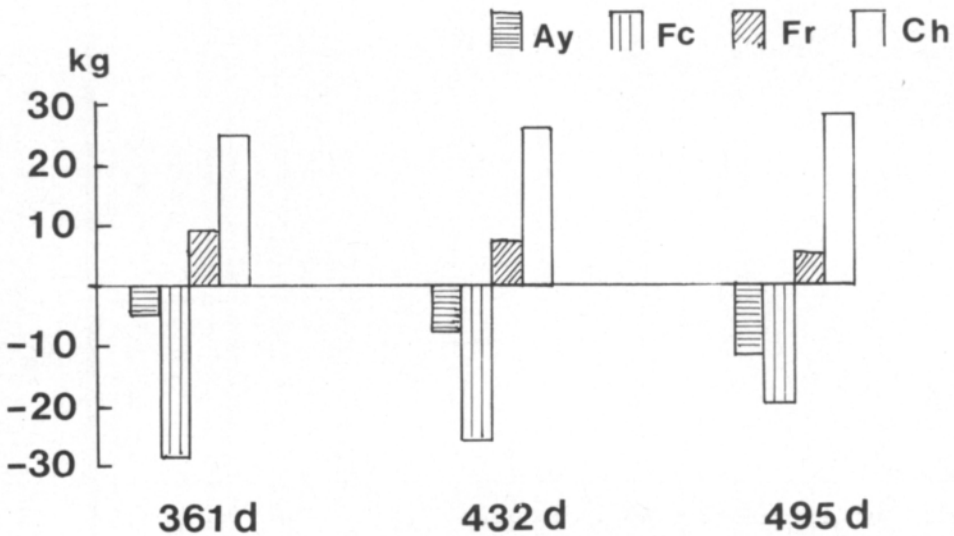


Fig. 3. Differences between breeds in carcass weight corrected for the average rearing time of the whole material and of each age group. Least squares constants. Effects of feed type, sex and year have been eliminated. N = 2 662.



Table 3. Carcass weight and net growth of the different breeds. Ay = 100.  $n_1$  = number of Ay animals,  $n_2$  = number of animals of other breeds.

Breed of sire	Bulls				Heifers			
	$n_1$	$n_2$	Carcass weight	Net growth	$n_1$	$n_2$	Carcass weight	Net growth
Ay			100	100			100	100
Fc	596	143	93	93	32	5	86	85
Fr	1434	413	111	112	65	33	115	117
Ch	883	106	116	117	69	24	127	130
Hf	112	7	102	103				
Ab	65	7	100	104				

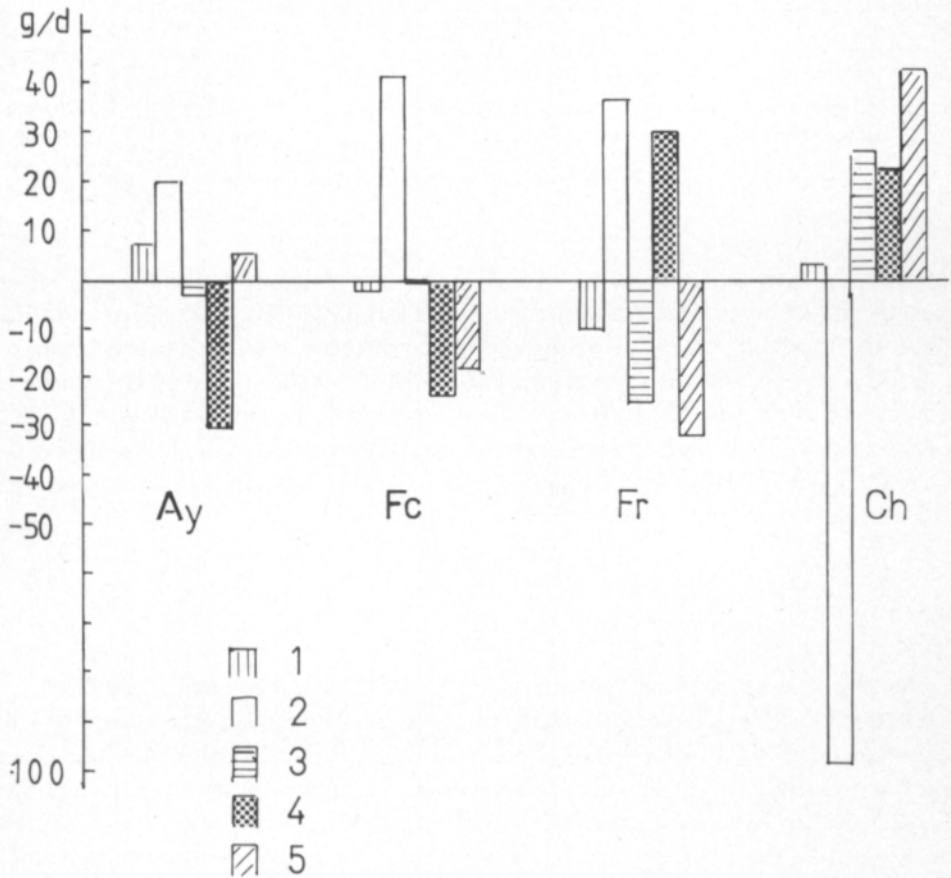


Fig. 4. Interaction between breed and feed type in net growth of the bulls. Least squares constants. Effects of breed, feed type, year, area and age group have been eliminated.  $N = 2\ 125$ .

time of each farm. This may partly be due to the dissimilar appetite and roughage conversion rate of the breeds. The Ay bulls grew relatively best on feeding based on roughage or on fodder of low quality (Fig. 4). However, on feeding based on concentrates the Ay bulls did not manage as well. The Fc bulls grew relatively best on scanty feeding, while the Ch bulls suffered

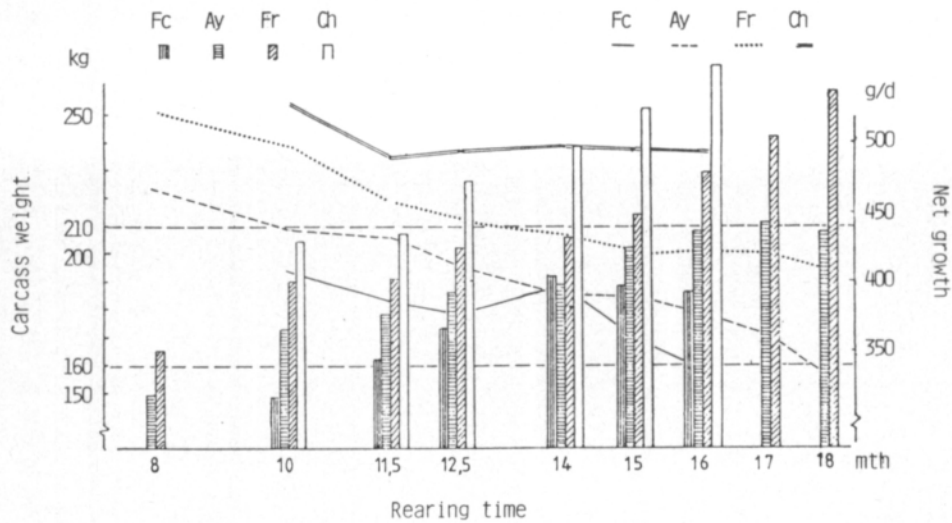


Fig. 5. Net growth rates and carcass weights of bulls of different breeds slaughtered at different ages. Animals were fattened indoors. N = 2 064.

clearly of the inadequate supply of feed. Lack of energy may often restrict the growth rate of large breeds in practical rearing (HOCKING & BOWMAN 1979). Matching the feed resources with the obtained breeds is often hard to arrange in production based on delivered calves. On the other hand it is easier to regulate rearing time. Differences between breeds became larger with age (Fig. 3 and 5). The high growth rate of the large breeds (Ch, Fr) continued longer than that of the small breeds (Ay, Fc). The benefits of crossbreeding will increase with age (PABST 1977).

### Sex of calf

As the results from experiments (e. g. POUTIAINEN and TUORI 1974, RUOHOMÄKI 1981) have indicated, the growth rate and carcass quality of bulls exceeded those of heifers (Tables 2 and 4). The differences between sexes were slightly larger than those found in experiments (RUOHOMÄKI 1981). Like in these experiments, the differences between sexes were larger for Ay and Fr than for Ch and Fc. The interaction between breed of sire and sex of calf was significant neither in carcass weight nor in net growth. In addition to differences in growth rate the differences in carcass weight may have been affected by the lighter calf weight and the lower dressing percentage of heifers (e.g. LINDHE 1968, PABST 1977, RUOHOMÄKI 1980 b). Differences between sexes increased with age (Fig. 6). This may partly be due to the differences in rearing time as growth rate grew less with age. In the younger age group the heifers were slaughtered 20 d younger, whereas in the older age group 45 d older than the bulls. Perhaps some of the dairy heifers were originally not intended for beef production.

Table 4. Carcass weight and net growth of the bulls as compared to the heifers of the same breed.  
Heifers = 100.  $n_1$  = number of heifers,  $n_2$  = number of bulls.

Breed of sire	$n_1$	$n_2$	Carcass weight	Net growth
Heifers			100	100
Bulls				
Ay	250	766	134	141
Fc	12	29	121	125
Fr	62	151	139	146
Ch	27	35	129	133

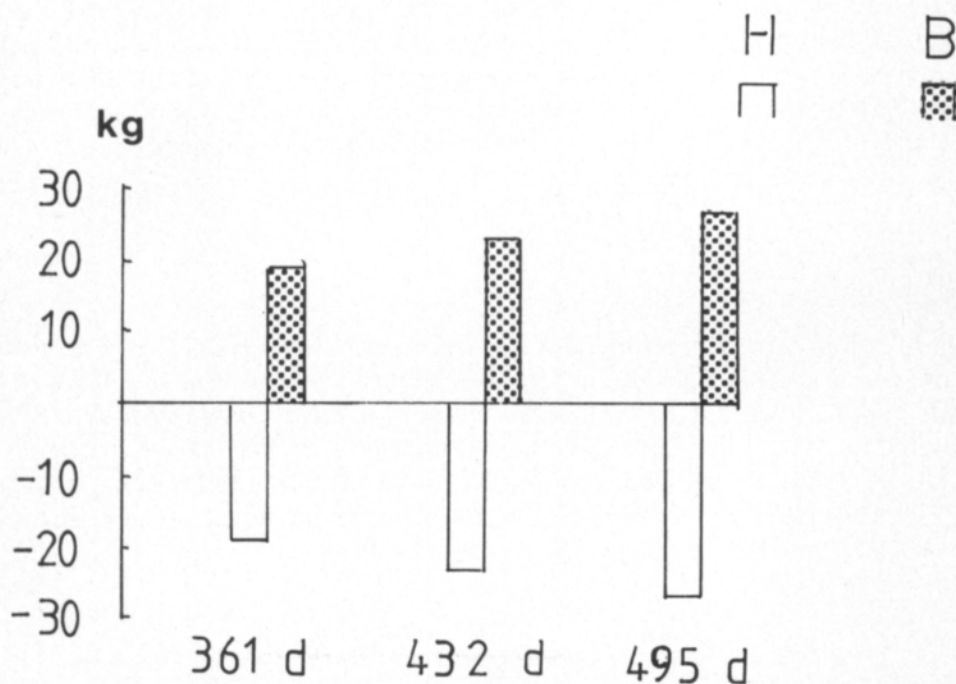


Fig. 6. Differences between heifers (H) and bulls (B) in carcass weight corrected for the average rearing time of the whole material and of each age group. Least squares constants. Effects of feed type, breed and year have been eliminated.  $N = 2\ 662$ .

## Farm

The most important factor affecting growth rate was the farm. In growth rate and carcass weight the variation between farms within feed type corresponded for about 50 % of the total variation and in carcass scores for about 25 % (Table 5). According to preliminary analyses there was more variation between farms in feed types based on roughage and pasture (types 1 and 5) than on concentrates (3 and 4). The share of farm of the total variation was

Table 5. Composition of variance, and proportion of farm for carcass traits. N = 2603.

Trait	Composition of variance	Share of farm, %
Carcass weight (432 d)	498.3 +11.8× 468.7	48.5
Rearing time	3394.4 +11.8×3541.8	51.1
Net growth	2546.5+11.8×2422.0	48.8
Carcass score	.46+11.8× .16	25.9
Fatness score	.15+11.8× .06	27.3

50 % in carcass weight and 53 % in net growth in feed types 1 and 5, and 41 % and 42 % in feed types 3 and 4, resp. The data included the present material and results of data collected in 1972–1980. On feeding based on roughage there were 894 bulls, on average 20,4 animals/farm, and on feeding based on concentrates 2064 bulls, on average 35.4 animals/farm. By drawing production plans for each farm and by recording the results the differences between farms could be reduced. In this way the efficiency of beef production could be improved.

## Sire

In addition to the considerable environmental effects on net growth and carcass traits, there were also genetical differences between the progenies of A.I. bulls (Tables 6 and 7). The heritabilities for carcass weight of Ay were similar to the results from dairy recording herds of MAIJALA (1972) and GRAVIR (1977) as well from the experiment of RUOHOMÄKI (1980 a).

Concerning the heritabilities for net growth and carcass weight there were inter-breed differences. There may have been differences in selection

Table 6. Composition of variance, and heritability estimates for carcass traits of Ay. N = 1235.

Trait	Composition of variance	Heritability
Carcass weight	762.3 +6.8× 45.9	.23±.09
Net growth	3749.1 +6.8×399.8	.39±.10
Carcass score	.45+6.8× .02	.14±.08
Fatness score	.158+6.8× .003	.06±.07

Table 7. Composition of variance, and heritability estimates for carcass traits of Fr. N = 453.

Trait	Composition of variance	Heritability
Carcass weight	659.1 +6.6×125.1	.61±.18
Net growth	3263.3 +6.6×776.2	.77±.25
Carcass score	.58+6.6× .02	.15±.13
Fatness score	.17+6.6× .01	.26±.15

intensity of the performance tested bulls within the breeds. However, as the number of progeny/sire was small, environmental effects like the variable distribution of breeds in age classes or feed types, may have influenced the differences between heritabilities. However, it seems possible to increase by selection the growth rate and carcass quality of our breeds, as well as by improving the rearing circumstances.

## Summary

Variation in growth rate and carcass quality and factors affecting the traits were studied on farms rearing delivered calves.

The material consisted of 4209 animals on 179 farms in different parts of the country. The data were collected in 1971–77. By composition the material corresponded with the average commercial calf material. On most farms feeding was based on green silage fodder with some domestic concentrates. On some farms the animals were also kept on pasture. Rearing time varied between 219–599 days.

The mean rearing time was 432 d, carcass weight 187 kg, and net growth 389 g/d.

Net growth and carcass traits were significantly affected by feed type, breed of sire, slaughter year, area, sex, and rearing time. During the study the carcass weight increased by 40 kg. Differences between areas grew somewhat smaller. The carcass weights were higher on feeding based on concentrates than on roughage and pasture, in spite of shorter rearing time.

The Ch crossbreds had on average the best growth rate and carcass quality and were followed by Fr, Ay and Fc. The order was the same in each feed type, age group and sex. The Ch crossbred bulls were 16 and Fr bulls 11 %-units heavier but Fc bulls 7 %-units lighter than the contemporary Ay bulls. Differences between heifers were still larger. The Ay bulls grew relatively best on feeding based on roughage or on fodder of low quality. The Fc bulls grew relatively best on scanty feeding, while the Ch bulls suffered clearly of the inadequate supply of feed. The high growth rate of the large breeds (Ch, Fr) continued longer than that of the small breeds (Ay, Fc).

Growth rate and carcass quality of bulls exceeded those of heifers. Differences between sexes were larger for Ay and Fr than for Ch and Fc. Differences between sexes increased with age.

The heritability estimates of Ay and (Fr) were .23 (.61) for carcass weight, .39 (.77) for net growth rate, .14 (.15) for carcass score and .06 (.26) for fatness score. It seems possible to increase by selection the growth rate and carcass quality of our breeds, as well as by improving the rearing circumstances.

The most important factor affecting growth rate was the farm. In growth rate and carcass weight the variation between farms within feed type corresponded for 50 % of the total variation, and in carcass scores for about 25 %. Feeding was more consistent on farms with mere indoor feeding than on farms where the animals were also kept on pasture. By drawing production

plans for each farm and by recording the results the differences between farms could be reduced. In this way the efficiency of beef production could be improved. In addition, beef recording data could be used for progeny testing of A.I. bulls to confirm the results obtained from performance testing.

**Acknowledgments.** I wish to express my gratitude to every person, farm and organization involved in the beef production experiments in field carried out by the Institute of Animal Breeding, Agricultural Research Center. Especially I wish to thank Prof. Kalle Maijala for the initiation and planning of the experiments.

Economically the work was supported by the Academy of Finland and the August Johannes and Aino Tiura Agricultural Research Foundation.

## Literature

- ANON. 1970 ja 1976. Keinosiemennysyhdistysten Liitto ry:n vuosikertomukset vuosilta 1970 ja 1976.
- GRAVIR, K. 1977. Opplegg og erfaring med feltmessig avkomsgranskning for kjøtt i Norge. Nordiskt Symposium kring individprovningsfrågor, Helsingfors 13.-14. 9. 1977. 10 p.
- HARVEY, W R. 1970. Estimation of variance and covariance components in the mixed model. *Biometrics* 26: 485-504.
- HOCKING, P. M. & BOWMAN, J. C. 1979. Genotype-environment interaction for beef production in a breed evaluation trial. *British Society of Animal Production*, Harrogate 19.-21. 3. 1979. Summary *Anim. Prod.* 28: 459.
- KENTTÄMIES, H. 1974. Teurasnaudan kasvukokeet yksityisillä tiloilla. *Kehittyvä Maatalous* 18: 16-24.  
— 1975. Ruokintatyyppin vaikutus lihanaudan kasvuun yksityisillä tiloilla suoritetuissa kokeissa. *Laudaturtyö*. 62 p.
- KOSSILA, V. & LAMPILA, M. 1974. Naudanlihan tuotanto vihreällä linjalla. *Kehittyvä Maatalous* 19: 20-38.
- LIBORIUSSEN, T. 1978. Brukskrydsning i SDM og RDM. En sammenlignende undersøgelse af otte kod- og kombinationsracers egnethed. 466. Beretn. fra Statens Husdyrbruksforsøg. 123 p.
- LINDHE, B. 1968. Crossbreeding for beef with Swedish Red and White cattle. Part I. Performance under varying field conditions. *Lantbr.högsk. Ann.* 34: 465-515.
- LINDSTRÖM, U. & MAIJALA, K. 1970. Evaluation of performance test results for A.I. bulls. *Acta Agric. Scand.* 20: 207-218.
- MAIJALA, K. 1972. Sonnien monipuolinen jälkeläisarvostelu II. *Karjalous* 48 (11): 480-483.
- MASON, I. L. 1957. Der Vergleich gleichzeitiger, gleichaltiger Stallgefährten (Contemporary Comparison). *Z. Tierzüchtg. Züchtgsbiol.* 70: 339-347.
- OJALA, M. 1982. Vanhempien tuotantotietojen ja eräiden ympäristötekijöiden yhteys sonnien kasvukoetuloksiin. *Kotieläinjalostuksen tiedote* no. 55, 54 p.
- PABST, W. 1977. Praxisübliche Wirtschaftsmast von männlichen und weiblichen Einfachgebrauchskreuzungen auf der Grundlage Deutsches Braunvieh und Deutsche Schwarzbunte. 3. Göttinger Tagung "Rindfleischerzeugung" 21./22. April 1977, pp. 32-52. Ed. Langholz, H.-J. & Pabst, W.
- POUTIAINEN, E. & TUORI, M. 1974. Hiehojen, härkien ja sonnien lihantuotannon vertailua. *Kehittyvä Maatalous* 19: 48-55.
- RICHARDSON, F. D. 1979. Some nutritional factors influencing the growth and efficiency of beef cattle at different ages and their implications for the design of regimes for the performance testing of young bulls; a review. *Rhod. J. agric. Res.* 17: 71-87.
- ROBERTSON, A. 1959. *Populationgenetik und quantitative Vererbung*. Handbuch der Tierzüchtung 2: 77-104. Hamburg und Berlin.
- RUOHOMÄKI, H. 1980 a. Painavien ja kevyiden ayrshiresonnien poikaryhmät lihantuotantokokeissa. *Lihantautokokeiden tuloksia IV. Kotieläinjalostuksen tiedote* no 40: 1-14.  
— 1980 b. Rotu- ja sukupuoliryhmien teuraspainojen ja teurasprosenttien vertailu lihantuotan-

- tokokeissa. Lihanautakokeiden tuloksia IV. Kotieläinjalostuksen tiedote no 40: 15–23.
- 1981. Lihakarjakokeet vuosina 1960–1980. Kotieläinjalostuksen tiedote no 46, 30 p.
- THIESSEN, R. B. 1978. Breed variation – growth and food efficiency. The British Council Course 827. Edinburgh-Aberdeen 7.–20. 5. 1978. Erip. 6 p.
- VARO, M. 1969. Ruhon laadun arvioimismenetelmistä elävistä ja teurastetuista naudoista. EAAP Helsinki 23.–26. 6. 1969. Erip. 16 p.
- WITT, M., ANDREAE, U. & KALLWEIT, E. 1971. Einfluss unterschiedlicher Fütterungsintensität auf Wachstum und Fettansatz beim Rind, untersucht an eineiigen Zwillingsbullen. Z-kunde 43: 173–186.

Ms received December 31, 1983

## SELOSTUS

# Lihanaudan teurasominaisuuksiin vaikuttavia perinnöllisiä ja ulkoisia tekijöitä kenttäkokeissa

## Hilkka Kenttämies

*Helsingin yliopisto, kotieläinten jalostustieteen laitos*

Lihanaudan kasvunopeuden ja teuraslaadun vaihtelua sekä niihin vaikuttavia tekijöitä tutkittiin Maatalouden tutkimuskeskuksen kotieläinjalostuslaitoksen kenttäkokeista ja Suomen Kotieläinjalostusyhdistyksen tarkkailusta vuosina 1971–77 kertyneiden teurastulosten pohjalta. Aineisto käsitti 4209 eläintä 179 eri puolilla Suomea sijaitsevassa karjassa, jotka kasvattivat pääasiassa ostovasikoita. Eläinainees vastasi keskimääräistä välitysvasikkatasoa. Eläimiä ruokittiin useimmilla tiloilla kotoisella nurmirehulla ja viljaväkirehulla, joillakin tiloilla eläimiä myös laidunnettiin. Kasvatusaika oli 219–599 pv.

Ominaisuuksiin vaikuttavia tekijöitä tutkittiin varianssianalyysillä pienimmän neliösumman menetelmää käyttäen. Eri rotuja ja sukupuolia verrattiin samalla tilalla samanaikaisesti kasvatettujen eläinten kesken.

Keskimääräinen kasvatusaika oli 432 pv, teuraspaino 187 kg ja nettokasvu 389 g/pv. Vaihtelukertoimet olivat vastaavasti 20, 21 ja 22 %.

Teurasominaisuuksiin vaikuttivat tilastollisesti merkitsevästi teurastusvuosi, teurastamo-alue, tilan ruokintatyyppi, eläimen ikä, sukupuoli ja rotu. Teuraspaino kohosi tutkimuksen aikana 40 kilolla, mihin vaikuttivat huomattavasti sekä kasvatusajan piteneminen että kasvatuksen tehostuminen. Alueelliset erot pienenevät jonkin verran. Kasvunopeus heikkeni eläinten vanhetessa. Sisäruokinnalla olleilla eläimillä kasvatusaika oli lyhempi, mutta teuraspaino suurempi kuin laidunnetuilla eläimillä. Ruokinnan voimakkuus vaikutti ilmeisesti enemmän teuraspainoon kuin kasvatusaika. Niukalla ja heinävaltaisella ruokinnalla olleet eläimet rasvoituivat herkemmin kuin runsaammin ruokitut.

Charolais-risteytyksillä oli keskimäärin paras kasvunopeus ja teuraslaatu, seuraavina olivat Fr, Ay ja Sk. Järjestys oli sama tarkasteltaessa tuloksia ruokintatyypeittäin, ikäryhmittäin ja sukupuolittain. Charolaisristeytyssonnit olivat 16 ja Fr-sonnit 11 %-yksikköä painavampia, mutta Sk-sonnit 7 %-yksikköä kevyempiä kuin vastaavat Ay-sonnit. Hiehoilla rotujen väliset erot olivat vielä suuremmat. Ay-sonnit kasvoivat suhteellisesti paremmin karkearehuvallaisella ja niukalla kuin väkirehuvallaisella ruokinnalla. Suomenkarja menestyi suhteellisesti parhaiten niukalla ruokinnalla, mutta Ch-risteytykset kärsivät selvästi puutteellisesta rehun saannista. Suurten rotujen (Ch, Fr) hyvä kasvu jatkui pitempään kuin pienten rotujen (Ay, Sk).

Sonnit olivat nopeakasvuisempia ja teuraslaadultaan parempia kuin hiehot ja erot suureni-  
vat eläinten vanhetessa. Sukupuolten väliset erot olivat Ay:llä ja Fr:llä suuremmat kuin Sk:lla  
ja Ch:lla.

Periytyvyysasteiden arvot olivat Ay:llä ja (Fr:llä) teuraspainossa .23 (.61), nettokasvussa  
.39 (.77), teurasarvosteluluokassa .14 (.15) ja rasvaisuusasteissa .06 (.26). Rotujemme teuras-  
ominaisuuksia pystytään ilmeisesti kehittämään myös valinnan avulla sen lisäksi, että paranne-  
taan kasvatusoloja.

Yksityisen tilan hoitotasolla oli suurin vaikutus teurasominaisuuksiin. Tilojen väliset erot  
ruokintatyyppin sisällä käsittivät noin 50 % teuraspainon ja nettokasvun sekä noin 25 %  
teurasarvostelupisteiden kokonaismuuntelusta. Kasvatus oli yhtenäisempää tiloilla, joilla eläi-  
met olivat pelkällä sisäruokinnalla kuin tiloilla, joilla eläimiä myös laidunnettiin. Tilakohtaisilla  
tuotantosuunnitelmissa ja niiden seurannalla pystyttäisiin kaikissa tuotantomuodoissa vähen-  
tämään tilojen välisiä eroja sekä tehostamaan tuotantoa. Lihantuotannon tarkkailutuloksia  
voitaisiin lisäksi käyttää keinosiemennyssonnien jälkeläisarvosteluun varmistamaan niiden  
yksilöarvostelutuloksia.